

**What is claimed is:**

- 1        1. An active filter that can be connected to a power line between a power  
2 source and a load, the active filter comprising:
  - 3              a current generator that can be connected to the power line, wherein in response  
4 to a control signal the current generator generates a current  $i_{APF}$  to compensate for  
5 polluting harmonics on the power line; and
  - 6              a controller that generates a control signal that controls the current generator to  
7 compensate for the polluting harmonics on the power line, such that the current  $i_{APF}$   
8 does not exceed a selected threshold value.
- 1        2. The active filter of claim 1, wherein the controller further includes a limiter  
2 that generates said control signal based on feedback values of the current  $i_{APF}$  and the  
3 current  $i_L$  flowing through the load, to control the current generator such that the current  
4  $i_{APF}$  does not exceed the selected threshold value.
- 1        3. The active filter of claim 2, further comprising:
  - 2              a first sensor that senses the current  $i_{APF}$  and provides a corresponding  
3 signal to the limiter that represents the feedback value for the current  $i_{APF}$ ; and
  - 4              a second sensor that senses the current  $i_L$  flowing through the load and  
5 provides a corresponding signal to the limiter that represents the feedback value for the  
6 current  $i_L$ .

1           4. The active filter of claim 2, wherein the limiter is configured to control the  
2 current generator such that even if the current  $i_{APF}$  necessary to compensate for the  
3 polluting harmonics on the power line exceeds said selected threshold value, the  
4 current  $i_{APF}$  generated by the current generator is limited to at most the selected  
5 threshold value.

1           5. The active filter of claim 2, wherein:  
2                 the power source comprises an input voltage source providing a voltage  
3      $v_s$ ; and  
4                 the limiter generates the control signal such that the current  $i_{APF}$  is  
5 controlled as:

$$6 \quad i_{APF} = \begin{cases} i_L - v_s / R_{EM} ; & |i_L - v_s / R_{EM}| < I_{\max} \\ I_{\max} ; & |i_L - v_s / R_{EM}| \geq I_{\max} \end{cases},$$

7                 where  $R_{EM}$  represents the equivalent resistance seen by the input  
8 voltage source  $v_s$ , and  $I_{\max}$  represents said selected threshold value.

1           6. The active filter of claim 5, further comprising a reference current  
2 generator that provides a reference current value to the controller, wherein the  
3 reference current value represents the ratio value  $V_s / R_{EM}$ .

1           7. The active filter of claim 6, wherein:

2                   the current generator includes an energy storage device that sources or  
3    sinks the current  $i_{APF}$  as necessary to compensate for polluting harmonics on the power  
4    line, wherein the current  $i_{APF}$  does not exceed the selected threshold value; and  
5                   the reference current generator receives a voltage feedback value from  
6    the current generator that represents the energy storage device voltage, and the  
7    reference current generator determines the value  $R_{EM}$  based on the voltage feedback  
8    value from the current generator, to achieve energy balance whereby the energy  
9    storage device voltage does not exceed a selected limit.

1       8.   The active filter of claim 1, wherein the current generator comprises:  
2                   an energy storage device; and  
3                   a switch controlled by the control signal from the controller, such that the  
4    energy storage device sources or sinks the current  $i_{APF}$  as necessary to compensate for  
5    polluting harmonics on the power line, wherein the current  $i_{APF}$  does not exceed a  
6    selected threshold value.

1       9.   The active filer of claim 8, wherein:  
2                   the energy storage device includes a capacitor device; and  
3                   the current generator further includes an inductor, such that the capacitor  
4    devices sources or sinks the current  $i_{APF}$ , through the inductor.

1           10. An active filter connected to a power line between a power source and a  
2 load to compensate for polluting harmonics on the power line, the active filter  
3 comprising:

4           a current generator connected to the power line in a parallel circuit with the  
5 power source and the load, wherein in response to a control signal the current  
6 generator generates a current  $i_{APF}$  to compensate for polluting harmonics on the power  
7 line; and

8           a current controller that controls the current generator to compensate for the  
9 polluting harmonics on the power line, the controller including:

10          a first sensor that senses the current  $i_{APF}$  and provides a corresponding signal  
11 that represents a feedback value for the current  $i_{APF}$ ;

12          a second sensor that senses the current  $i_L$  flowing through the load and provides  
13 a corresponding signal that represents the feedback value for the current  $i_L$ ; and

14          a limiter that generates said control signal based on feedback values of the  
15 current  $i_{APF}$  and the current  $i_L$ , wherein the limiter is configured to control the current  
16 generator such that if the current  $i_{APF}$  necessary to compensate for the polluting  
17 harmonics on the power line exceeds a selected threshold value, the current  $i_{APF}$   
18 generated by the current generator is limited to at most the selected threshold value.

1           11. The active filter of claim 10, wherein:

2           the power source comprises an input voltage source providing a voltage  
3  $v_s$ ; and

4                   the limiter generates the control signal such that the current  $i_{APF}$  is  
 5   controlled as:

$$6 \quad i_{APF} = \begin{cases} i_L - v_S / R_{EM} ; & |i_L - v_S / R_{EM}| < I_{\max} \\ I_{\max} ; & |i_L - v_S / R_{EM}| \geq I_{\max} \end{cases},$$

7                   where  $R_{EM}$  represents the equivalent resistance seen by the input  
 8   voltage source  $v_S$ , and  $I_{\max}$  represents said selected threshold value.

1                 12. The active filter of claim 11, further comprising a reference current  
 2   generator that provides a reference current value to the controller, wherein the  
 3   reference current value represents the ratio value  $V_S / R_{EM}$ .

1                 13. The active filter of claim 12, wherein:  
 2                   the current generator includes an energy storage device that sources or  
 3   sinks the current  $i_{APF}$  as necessary to compensate for polluting harmonics on the power  
 4   line, wherein the current  $i_{APF}$  does not exceed the selected threshold value; and  
 5                   the reference current generator receives a feedback value from the  
 6   current generator that represents the level of the energy stored in the energy storage  
 7   device, and the reference current generator determines the value  $R_{EM}$  based on the  
 8   feedback value from the current generator, to achieve energy balance whereby the  
 9   energy level of the energy storage device is maintained within predetermined limits.

1        14. The active filter of claim 13, wherein the current generator further  
2 comprises a switch controlled by the control signal from the controller, such that the  
3 energy storage device sources or sinks the current  $i_{APF}$  as necessary to compensate for  
4 polluting harmonics on the power line, wherein the current  $i_{APF}$  does not exceed a  
5 selected threshold value.

1        15. The active filer of claim 14, wherein:  
2              the energy storage device includes a capacitor device; and  
3              the current generator further includes an inductor, such that the capacitor  
4 devices sources or sinks the current  $i_{APF}$ , through the inductor.

1        16. A method of filtering a power line having a power source and a load  
2 connected thereto, comprising the steps of:  
3              providing a current generator that can be connected to the power line, wherein  
4 the current generator generates a current  $i_{APF}$  to compensate for polluting harmonics on  
5 the power line; and  
6              controlling the current generator to compensate for the polluting harmonics on  
7 the power line, such that the current  $i_{APF}$  does not exceed a selected threshold value.

1        17. The method of claim 16, wherein the steps of controlling the current  
2 generator further includes the steps of controlling the current generator based on  
3 feedback values of the current  $i_{APF}$  and the current  $i_L$  flowing through the load, such that  
4 the current  $i_{APF}$  does not exceed the selected threshold value.

1           18. The method of claim 17, wherein the steps of controlling the current  
2 generator further includes the step of:

3                 sensing the APF current  $i_{APF}$  with a first sensor that provides a  
4 corresponding signal representing the feedback value for the current  $i_{APF}$ ; and  
5                 sensing the load current  $i_L$  with a second sensor that provides a  
6 corresponding signal representing the feedback value for the current  $i_L$ .

1           19. The method of claim 17, wherein the steps of controlling the current  
2 generator further includes the step of:

3                 controlling the current generator such that even if the current  $i_{APF}$   
4 necessary to compensate for the polluting harmonics on the power line exceeds said  
5 selected threshold value, the current  $i_{APF}$  generated by the current generator is limited  
6 to at most the selected threshold value.

1           20. The method of claim 17, wherein:

2                 the power source comprises an input voltage source providing a voltage  
3  $v_S$ ; and

4                 the current  $i_{APF}$  is controlled such that:

5                 
$$i_{APF} = \begin{cases} i_L - v_S / R_{EM} ; & |i_L - v_S / R_{EM}| < I_{\max} \\ I_{\max} ; & |i_L - v_S / R_{EM}| \geq I_{\max} \end{cases}$$

6                 where  $R_{EM}$  represents the equivalent resistance seen by the input  
7 voltage source  $v_S$ , and  $I_{\max}$  represents said selected threshold value.

1           21. The method of claim 20, further comprising the steps of determining a  
2 reference current value that represents the ratio value  $V_S / R_{EM}$ .

1           22. The method of claim 21, wherein:  
2                 the current generator includes an energy storage device that sources or  
3 sinks the current  $i_{APF}$  as necessary to compensate for polluting harmonics on the power  
4 line, wherein the current  $i_{APF}$  does not exceed the selected threshold value; and  
5                 the steps of determining a reference current value, further includes the  
6 steps of receiving a voltage feedback value from the current generator that represents  
7 the energy storage device voltage, and determining the value  $R_{EM}$  based on the voltage  
8 feedback value from the current generator, to achieve energy balance whereby the  
9 energy storage device voltage does not exceed a selected limit.

1           23. The method of claim 16, wherein the current generator comprises:  
2                 an energy storage device; and  
3                 a controllable switch, such that the energy storage device sources or sinks  
4 the current  $i_{APF}$  as necessary to compensate for polluting harmonics on the power line,  
5 wherein the current  $i_{APF}$  does not exceed a selected threshold value.

1           24. The method of claim 23, wherein:  
2                 the energy storage device includes a capacitor device; and  
3                 the current generator further includes an inductor, such that the capacitor  
4 devices sources or sinks the current  $i_{APF}$ , through the inductor.

1        25. The method of claim 16, wherein the step of controlling the current  
2 generator further includes controlling the current generator to compensate for the  
3 polluting harmonics on the power line, such that the current  $i_{APF}$  is bounded by a  
4 selected upper threshold and a selected lower threshold.